

Original article

Factors Associated with Delayed Recovery of Awakening After General Anesthesia in Patients Undergoing General Surgery: A observational Cross-Sectional Study at a Mayo Hospital in Lahore, Pakistan

Muhammad Danish¹, Mazhar Abbas¹, Muhammad Numan¹, Malik Ahmad Arif¹, Inam Ullah^{2*}, Awais Akhtar¹, Taimoor Riaz Ullah¹

¹ Department of Anesthesia Technology, University of Lahore, Lahore, Pakistan

² Lecturer, Department of Health Professional Technologies, Faculty of Allied Health Sciences, University of Lahore, Lahore, Pakistan

*Correspondence: Inam Ullah, inamullah@dhpt.uol.edu.pk

Received: 23 September 2024 | Accepted: 7 December 2024 | Published: 31 December 2024

How to Cite: Danish, M. et al. 2024. Factors Associated with Delayed Recovery of Awakening After General Anesthesia in Patients Undergoing General Surgery: A observational Cross-Sectional Study at a Mayo Hospital in Lahore, Pakistan. Journal of Perioperative and Critical Care Sciences. 2, 2 (Dec. 2024), 1–7.

ABSTRACT

Background: Delayed emergence after general anesthesia can prolong post-anesthesia care, but evidence from Pakistan is limited. **Objective:** To determine the proportion of delayed recovery and examine associated factors among general surgery patients. **Methods:** This observational cross-sectional study included 150 patients undergoing general surgery under general anesthesia at Mayo Hospital, Lahore, during September and October 2024. Delayed recovery was defined as awakening more than 30 minutes after anesthesia cessation. Associations were assessed using Pearson's chi-square test and crude odds ratios (ORs) with 95% confidence intervals (CIs). **Results:** Delayed recovery occurred in 53 patients (35.3%; 95% CI 28.1–43.3). Higher crude odds were observed among males (OR 2.50, 95% CI 1.17–5.34), smokers (OR 2.14, 95% CI 1.08–4.23), alcohol users (OR 2.19, 95% CI 1.05–4.58), and patients with diabetes mellitus (OR 2.53, 95% CI 1.27–5.03). BMI category was not associated with delayed recovery ($p=0.832$). **Conclusion:** Delayed recovery was frequent in this cohort, and several demographic, lifestyle, and metabolic characteristics showed crude associations. Prospective multivariable studies are needed before these variables are used for clinical prediction. **Keywords:** Delayed recovery, Delayed emergence, General anesthesia, General surgery, Post-anesthesia care unit, Associated factors

EDITORIAL INFORMATION

Author Contributions: Concept: MD, MA; Design: MD, MA, IU; Data Collection: MD, MN, MAA, AA, TRU; Analysis: MA, IU; Drafting: MD, MA, MN, MAA, IU, AA, TRU

Ethical Approval: Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

Informed Consent: Written informed consent was obtained from all participants

Conflict of Interest: The authors declare no conflict of interest; **Funding:** No external funding; **Data Availability:** Available from the corresponding author on reasonable request; **Acknowledgments:** N/A.

INTRODUCTION

Emergence from general anesthesia is the transition from drug-induced unconsciousness to wakefulness, purposeful responsiveness, protective airway reflexes, and adequate spontaneous ventilation. It is an active neurobiological process rather than a simple reversal of induction, and its course reflects the interaction of anesthetic concentration, arousal networks, patient physiology, and surgical stimulation (1). Most patients respond within minutes after anesthetic administration is discontinued; however, recovery may be slower than expected and can delay transfer from the operating room or progression through the post-anesthesia care unit (PACU).

Delayed emergence, delayed awakening, and hypoactive emergence are related but not always identically defined outcomes. In clinical practice, delayed emergence generally refers to persistent unresponsiveness or failure to regain an expected level of consciousness after anesthetic drugs have been stopped. It should be distinguished from emergence delirium, in which the patient is awake but agitated, disoriented, or behaviorally disturbed. The differential diagnosis is broad: residual hypnotics, opioids, benzodiazepines, and neuromuscular blocking drugs are common contributors, while hypoventilation, hypoxemia, hypercapnia, hypothermia, hypoglycemia, electrolyte disturbance, hepatic or renal dysfunction, and acute neurological events must also be considered (2–5). Because some non-

pharmacological causes are time-critical, delayed awakening requires continued airway and cardiorespiratory support while reversible causes are assessed systematically.

The probability and duration of delayed recovery depend on patient, anesthetic, and procedural characteristics. Prospective PACU data have associated hypoactive emergence with age, longer operations, and intra-abdominal surgery, although definitions and case mix strongly influence the estimates (6). Studies in selected populations have also implicated long-acting sedative or antiepileptic medication, cumulative anesthetic exposure, and procedure-related factors (7,8). Sex-related differences in anesthetic sensitivity and recovery have been described, but findings are not uniform and may be modified by the drugs and neuromuscular blockers used (9). These observations support evaluation of demographic characteristics alongside comorbidity, lifestyle exposure, anesthetic duration, and intraoperative physiology rather than attributing delayed awakening to a single cause.

Reported occurrence varies markedly across settings. A cross-sectional study of 311 elective surgical patients reported delayed awakening in 2.6%, with opioid exposure, prolonged surgery, blood loss, fluid administration, and intraoperative hypotension among the associated factors (10). In 168 patients undergoing radical biliary surgery, delayed recovery occurred in 25%; older age, body mass index (BMI) of 25 kg/m² or greater, alcohol use, smoking, longer surgery and anesthesia, and sevoflurane exposure were identified as independent factors (11). Conversely, a large retrospective PACU cohort of 38,796 surgical patients found an aggregate rate of 1.38% and linked delayed recovery to older age, neurosurgery, longer anesthesia, ASA III status, and postoperative analgesia (12). The wide variation across these studies indicates that the selected time threshold, recovery assessment, surgical population, anesthetic technique, and statistical adjustment materially affect both incidence estimates and identified predictors.

Several potentially modifiable mechanisms are clinically important. Accumulation and redistribution of inhaled or intravenous anesthetics increase with exposure duration and drug solubility, so the time required for brain concentration to fall to an awakening level may be context dependent (13). Perioperative hypothermia can slow drug metabolism and prolong recovery (14). Residual neuromuscular blockade does not itself prevent consciousness, but it can produce apparent unresponsiveness, airway obstruction, impaired ventilation, and critical respiratory events; quantitative neuromuscular monitoring and appropriate reversal therefore remain central to safe recovery (15-17). Trials of electroencephalographic bispectral-index guidance have also shown that closer titration of propofol or volatile anesthetic delivery can reduce anesthetic consumption and accelerate early recovery in selected patients (18,19).

Assessment of recovery should combine consciousness with ventilation, oxygenation, circulation, motor function, and other clinically relevant domains. International post anesthetic-care guidance and established recovery scores provide structured approaches to documenting these domains (20-22). Recent reviews continue to emphasize that a simple time-to-awakening threshold is useful for identifying delayed consciousness but is narrower than a multidimensional assessment of readiness for PACU discharge (23,24). Evidence from Pakistani public-sector hospitals remains scarce, limiting locally relevant estimates and comparison with international cohorts. This study therefore aimed to determine the proportion of general surgery patients with delayed recovery of awakening, defined as awakening more than 30 minutes after cessation of anesthesia, at Mayo Hospital, Lahore, and to examine its crude associations with selected demographic, lifestyle, and clinical characteristics.

MATERIALS AND METHODS

This observational cross-sectional study was conducted in the Department of Anesthesiology at Mayo Hospital, Lahore, Pakistan, during September and October 2024. The study included 150 adult patients undergoing general surgical procedures under general anesthesia. Eligible patients were enrolled after written informed consent; patients with heart disease were excluded.

Demographic and clinical data were recorded on a structured proforma, including age, sex, BMI, ASA physical status, diabetes mellitus, hypertension, previous surgery or anesthesia, smoking, alcohol use, and preoperative vital signs. Anesthetic and operating-room records provided procedural duration, anesthetic exposure, muscle-relaxant use, blood loss, fluid administration, and documented

intraoperative adverse events. Awakening time was observed during immediate postoperative care. Delayed recovery was defined as awakening more than 30 minutes after cessation of anesthesia; awakening within 30 minutes was classified as normal recovery.

Data were analyzed in IBM SPSS Statistics version 27.0. Categorical data are reported as n (%) and physiological measures as mean $\pm$ SD. Pearson's chi-square test assessed crude associations; crude odds ratios with 95% confidence intervals were calculated for binary variables and BMI categories, with normal BMI as the reference. Tests were two-sided ($p < 0.05$). The Institutional Ethical Review Committee granted Institutional Review Board (Ref. No.: DRC/DHPT011/05/24), before data collection and Mayo Hospital granted administrative permission. Records were de-identified and handled according to the Declaration of Helsinki (25).

RESULTS

All 150 enrolled patients were included in the reported analysis. Half were aged 31-45 years, and patients older than 60 years represented 2.0% of the cohort. Males accounted for 64.7%, while 60.7% were overweight or obese within the recorded BMI categories. Smoking, alcohol use, and diabetes mellitus were reported by 42.7%, 27.3%, and 42.0% of participants, respectively.

Table 1. Demographic and clinical characteristics of the study population

Characteristic	n	%
Age 18-30 years	35	23.3
Age 31-45 years	75	50.0
Age 46-60 years	37	24.7
Age >60 years	3	2.0
Male	97	64.7
Female	53	35.3
BMI <18.5 kg/m ²	11	7.3
BMI 18.5-24.9 kg/m ²	48	32.0
BMI 25.0-29.9 kg/m ²	43	28.7
BMI 30.0-34.9 kg/m ²	48	32.0
Smoker	64	42.7
Non-smoker	86	57.3
Alcohol use	41	27.3
No alcohol use	109	72.7
ASA I	25	16.7
ASA II	125	83.3
Diabetes mellitus	63	42.0
No diabetes mellitus	87	58.0

The cohort was predominantly ASA II (83.3%). Within the available BMI distribution, 28.7% were overweight and 32.0% were in the 30.0-34.9 kg/m² category.

Table 2. Preoperative physiological measurements

Variable	Mean $\pm$ SD
Systolic blood pressure, mmHg	133.1 $\pm$ 14.0
Diastolic blood pressure, mmHg	90.6 $\pm$ 10.8
Heart rate, beats/min	92.8 $\pm$ 6.3
Respiratory rate, breaths/min	17.8 $\pm$ 2.4
Oxygen saturation, %	97.2 $\pm$ 2.4

Mean preoperative systolic and diastolic blood pressures were 133.1 $\pm$ 14.0 and 90.6 $\pm$ 10.8 mmHg, respectively. Mean oxygen saturation was 97.2 $\pm$ 2.4%.

Table 3. Recovery status after general anesthesia

Recovery status	n	%	95% CI
Normal recovery (≤ 30 min)	97	64.7	56.7-71.9
Delayed recovery (> 30 min)	53	35.3	28.1-43.3

Delayed recovery occurred in 53 of 150 patients (35.3%; 95% CI 28.1-43.3), while 97 patients (64.7%) awakened within 30 minutes.

Table 4. Crude associations between selected characteristics and delayed recovery

Variable	Category	Delayed (%)	n/N Normal (%)	n/N Crude (95% CI)	OR p-value
Sex	Female	12/53 (22.6)	41/53 (77.4)	1.00 (reference)	0.016
	Male	41/97 (42.3)	56/97 (57.7)	2.50 (1.17-5.34)	
Smoking	No	24/86 (27.9)	62/86 (72.1)	1.00 (reference)	0.027
	Yes	29/64 (45.3)	35/64 (54.7)	2.14 (1.08-4.23)	
Alcohol use	No	33/109 (30.3)	76/109 (69.7)	1.00 (reference)	0.035
	Yes	20/41 (48.8)	21/41 (51.2)	2.19 (1.05-4.58)	
Diabetes mellitus	No	23/87 (26.4)	64/87 (73.6)	1.00 (reference)	0.007
	Yes	30/63 (47.6)	33/63 (52.4)	2.53 (1.27-5.03)	
BMI category	18.5-24.9	17/48 (35.4)	31/48 (64.6)	1.00 (reference)	0.832
	<18.5	4/11 (36.4)	7/11 (63.6)	1.04 (0.27-4.07)	
	25.0-29.9	13/43 (30.2)	30/43 (69.8)	0.79 (0.33-1.90)	
	30.0-34.9	19/48 (39.6)	29/48 (60.4)	1.19 (0.52-2.73)	

OR, odds ratio; CI, confidence interval; BMI, body mass index. P-values are from Pearson's chi-square tests and represent the overall association for each variable. All estimates are unadjusted.

Male patients had higher crude odds of delayed recovery than female patients (OR 2.50, 95% CI 1.17-5.34; $p=0.016$). Delayed recovery was also more frequent among smokers than non-smokers (45.3% vs. 27.9%; OR 2.14, 95% CI 1.08-4.23; $p=0.027$), among alcohol users than non-users (48.8% vs. 30.3%; OR 2.19, 95% CI 1.05-4.58; $p=0.035$), and among patients with diabetes mellitus than those without diabetes (47.6% vs. 26.4%; OR 2.53, 95% CI 1.27-5.03; $p=0.007$). BMI category was not associated with delayed recovery (chi-square=0.87; $p=0.832$).

Figure 1. Unadjusted associations with delayed recovery.

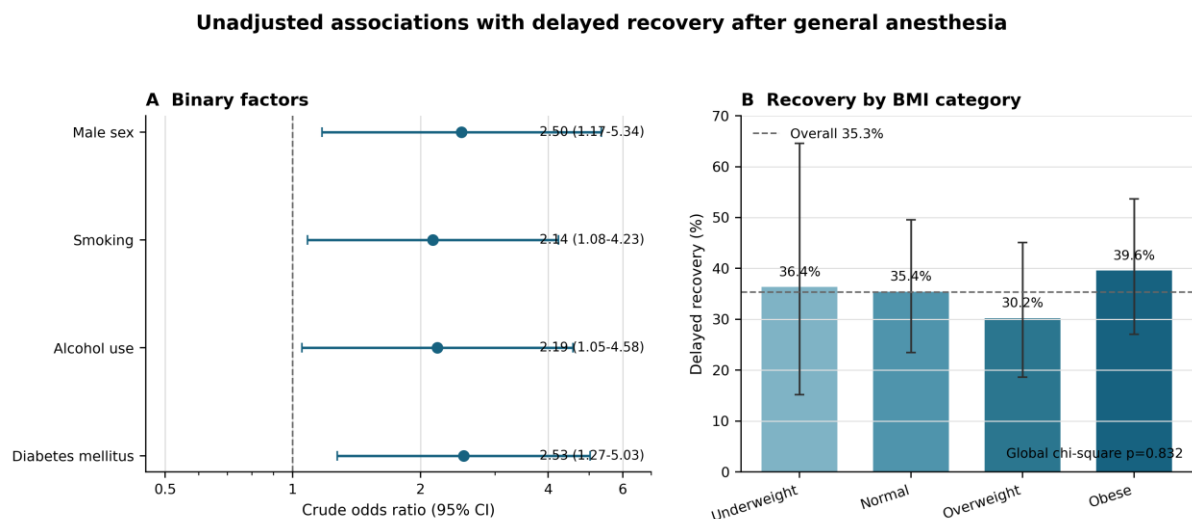


Figure 1 summarizes the crude effect estimates and BMI-specific recovery proportions. The largest crude estimate was observed for diabetes mellitus (OR 2.53), followed by male sex (OR 2.50), alcohol use (OR 2.19), and smoking (OR 2.14); all four confidence intervals narrowly excluded 1.00. Delayed-recovery proportions varied from 30.2% in the overweight category to 39.6% in the 30.0-34.9 kg/m² category, but the global BMI comparison showed no evidence of association ($p=0.832$).

DISCUSSION

More than one-third of patients in this cohort experienced delayed recovery using a threshold of more than 30 minutes after anesthesia cessation. Male sex, smoking, alcohol use, and diabetes mellitus were associated with higher odds in crude analyses, whereas BMI category was not associated with recovery status. These results identify characteristics for further investigation but do not establish independent prediction or causation.

The observed proportion of 35.3% was substantially higher than the 2.6% reported by Bayable and colleagues among elective surgical patients, the 25% reported in radical biliary surgery, and the 1.38% reported in a large PACU cohort (10-12). Direct comparison is limited because delayed emergence is sensitive to the selected time threshold, patient case mix, operative duration, anesthetic exposure, and method used to assess responsiveness (2-5). The present 95% CI was also wide enough to indicate appreciable uncertainty around the single-center estimate.

The associations with smoking and alcohol use were directionally consistent with the adjusted findings reported by Zhang and colleagues (11). Male sex and diabetes mellitus also showed approximately 2.5-fold crude odds, but these estimates may reflect confounding by comorbidity, anesthetic technique, or procedure-related factors. Published evidence on sex and emergence is mixed, and drug-specific responses may contribute to observed differences (8,9). Diabetes may influence recovery through perioperative metabolic disturbance, whereas smoking and alcohol exposure may alter respiratory or pharmacological responses; nevertheless, the present analysis cannot determine the responsible mechanisms (2-5).

BMI category was not associated with delayed recovery. Rates were similar across categories, and every category-specific confidence interval included the null value. This finding differs from the radical biliary surgery study, which identified BMI of 25 kg/m² or greater as an independent factor (11). Differences in surgical population, anesthetic duration, exposure measurement, and statistical adjustment may explain the discrepancy. The pharmacokinetics of inhaled anesthetics vary with agent, duration, tissue solubility, and the decrement required for recovery, making a simple BMI explanation insufficient (13).

The study provides a clinically relevant estimate from a large public-sector hospital and reports complete denominators for the principal variables presented. Its limitations include the single center design, moderate sample size, limited representation of patients older than 60 years, crude rather than multivariable analysis, and reliance on a time-based recovery threshold. A time threshold does not capture all dimensions of physiological and functional recovery assessed by established post-anesthesia scoring systems (20-24). The association analysis also does not account for anesthetic dose, residual neuromuscular blockade, duration of surgery and anesthesia, temperature, or metabolic abnormalities, all of which can influence early recovery (13-17). Future prospective studies should use a reproducible responsiveness measure, document major anesthetic exposures, and apply multivariable modelling before developing a clinical prediction approach.

CONCLUSION

Delayed recovery occurred in 35.3% of patients. Male sex, smoking, alcohol use, and diabetes mellitus showed higher crude odds, whereas BMI category was not associated with recovery status. These findings require prospective multivariable confirmation and should not be interpreted as independent or causal effects.

REFERENCES

1. Brown EN, Lydic R, Schiff ND. General anesthesia, sleep, and coma. *N Engl J Med*. 2010;363(27):2638-2650. doi:10.1056/NEJMr0808281.
2. Cascella M, Bimonte S, Di Napoli R. Delayed emergence from anesthesia: what we know and how we act. *Local Reg Anesth*. 2020;13:195-206. doi:10.2147/LRA.S230728.
3. Thomas E, Martin F, Pollard B. Delayed recovery of consciousness after general anaesthesia. *BJA Educ*. 2020;20(5):173-179. doi:10.1016/j.bjae.2020.01.007.
4. Misal US, Joshi SA, Shaikh MM. Delayed recovery from anesthesia: a postgraduate educational review. *Anesth Essays Res*. 2016;10(2):164-172. doi:10.4103/0259-1162.165506.
5. Tzabazis A, Miller C, Dobrow MF, Zheng K, Brock-Utne JG. Delayed emergence after anesthesia. *J Clin Anesth*. 2015;27(4):353-360. doi:10.1016/j.jclinane.2015.03.023.
6. Radtke FM, Franck M, Hagemann L, Seeling M, Wernecke KD, Spies CD. Risk factors for inadequate emergence after anesthesia: emergence delirium and hypoactive emergence. *Minerva Anestesiol*. 2010;76(6):394-403.
7. Maeda S, Tomoyasu Y, Higuchi H, Ishii-Maruhama M, Egusa M, Miyawaki T. Independent predictors of delay in emergence from general anesthesia. *Anesth Prog*. 2015;62(1):8-13. doi:10.2344/0003-3006-62.1.8.
8. Apfelbaum JL, Grasela TH, Hug CC Jr, McLeskey CH, Nahrwold ML, Roizen MF, et al. The initial clinical experience of 1819 physicians in maintaining anesthesia with propofol: characteristics associated with prolonged time to awakening. *Anesth Analg*. 1993;77(4 Suppl):S10-S14.
9. Buchanan FF, Myles PS, Leslie K, Forbes A, Cicuttini F. Gender and recovery after general anesthesia combined with neuromuscular blocking drugs. *Anesth Analg*. 2006;102(1):291-297. doi:10.1213/01.ANE.0000181321.55422.C6.
10. Bayable SD, Amberbir WD, Fetene MB. Delayed awakening and its associated factor following general anesthesia service, 2022: a cross-sectional study. *Ann Med Surg (Lond)*. 2023;85(9):4321-4328. doi:10.1097/MS9.0000000000001103.
11. Zhang G, Pan B, Tan D, Ling Y. Risk factors of delayed recovery from general anesthesia in patients undergoing radical biliary surgery: what can we prevent? *Medicine (Baltimore)*. 2021;100(32):e26773. doi:10.1097/MD.00000000000026773.
12. Zhang Q, Xu F, Xuan D, Huang L, Shi M, Yue Z, et al. Risk factors for delayed recovery in postanesthesia care unit after surgery: a large and retrospective cohort study. *Int J Surg*. 2023;109(5):1281-1290. doi:10.1097/JS9.0000000000000364.
13. Eger EI 2nd, Shafer SL. Tutorial: context-sensitive decrement times for inhaled anesthetics. *Anesth Analg*. 2005;101(3):688-696. doi:10.1213/01.ANE.0000158611.15820.3D.
14. Sessler DI. Perioperative thermoregulation and heat balance. *Lancet*. 2016;387(10038):2655-2664. doi:10.1016/S0140-6736(15)00981-2.
15. Debaene B, Plaud B, Dilly MP, Donati F. Residual paralysis in the PACU after a single intubating dose of nondepolarizing muscle relaxant with an intermediate duration of action. *Anesthesiology*. 2003;98(5):1042-1048. doi:10.1097/00000542-200305000-00004.
16. Murphy GS, Szokol JW, Marymont JH, Greenberg SB, Avram MJ, Vender JS. Residual neuromuscular blockade and critical respiratory events in the postanesthesia care unit. *Anesth Analg*. 2008;107(1):130-137. doi:10.1213/ane.0b013e31816d1268.
17. Brull SJ, Kopman AF. Current status of neuromuscular reversal and monitoring: challenges and opportunities. *Anesthesiology*. 2017;126(1):173-190. doi:10.1097/ALN.0000000000001409.

18. Gan TJ, Glass PS, Windsor A, Payne F, Rosow C, Sebel P. Bispectral index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. *Anesthesiology*. 1997;87(4):808-815. doi:10.1097/00000542-199710000-00014.
19. Song D, Joshi GP, White PF. Titration of volatile anesthetics using bispectral index facilitates recovery after ambulatory anesthesia. *Anesthesiology*. 1997;87(4):842-848. doi:10.1097/00000542-199710000-00018.
20. Apfelbaum JL, Silverstein JH, Chung FF, Connis RT, Fillmore RB, Hunt SE, et al. Practice guidelines for postanesthetic care: an updated report by the American Society of Anesthesiologists Task Force on Postanesthetic Care. *Anesthesiology*. 2013;118(2):291-307. doi:10.1097/ALN.0b013e31827773e9.
21. Aldrete JA, Kroulik D. A postanesthetic recovery score. *Anesth Analg*. 1970;49(6):924-934. doi:10.1213/00000539-197011000-00020.
22. Steward DJ. A simplified scoring system for the post-operative recovery room. *Can Anaesth Soc J*. 1975;22(1):111-113. doi:10.1007/BF03004827.
23. Deshmukh PP, Chakole V. Post-anesthesia recovery: a comprehensive review of Sampe, Modified Aldrete, and White scoring systems. *Cureus*. 2024;16(10):e70935. doi:10.7759/cureus.70935.
24. El Aoufy K, Forciniti C, Longobucco Y, Lucchini A, Mangli I, Magi CE, et al. A comparison among score systems for discharging patients from recovery rooms: a narrative review. *Nurs Rep*. 2024;14(4):2777-2794. doi:10.3390/nursrep14040205.
25. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191-2194. doi:10.1001/jama.2013.281053.